The Effects of Student Narration in College Engineering Classes

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Abstract

Narration is a technique that has been used successfully in many contexts as part of K-12 education. Despite the significant use and success of this technique in certain primary education contexts, its use has not been documented in higher education. This research provides initial understanding of how narration might enhance undergraduate engineering education. By asking students in an mechanical engineering classes at the Air Force Academy to narrate, recite, and reflect on a pertinent selection of text from the course's textbook in class, the authors hypothesized that students would demonstrate an increase in conceptual understanding of course material. Additionally, the authors believed the students' perception of the narration method might have an impact on the technique's success. The study investigated whether quiz performance was impacted by the incoming GPA of the student, participation in the narration condition, and the students' overall qualitative impression of the narration technique's perceived benefits. While there was no significant change in the quiz performance of the overall class using narration, the individual students who narrated performed 44% higher on the narrated material than expected, based on the overall course performance on the exams. Furthermore, those participating in the narration discussion of a particular topic had 14% more correct responses than expected on the all-or-nothing quiz results. While the benefits on conceptual understanding seem to be restricted to the individuals who performed the narration or follow-on discussions in our current implementation, we believe there is potential for further refinements to provide broader benefits.

Keywords

narration; Charlotte Mason, reciprocal teaching, retelling

1.0 Introduction

Engineering instruction at the undergraduate collegiate level is primarily executed through teaching students how to solve work-out problems, which is not effective for developing conceptual understanding. The current study investigates the premise that a student's oral narration of the conceptual portions of engineering texts is a viable approach to develop conceptual understanding. Thus, we are intentionally bringing student attention to the connective paragraphs rather than the example problems.

1.1 Narration Approach Background

The narration approach is the oral practice of a student reading a passage of text, summarizing the key points, and concluding key thoughts from the text. It has been successful at the K-12 levels at developing not only general learning, but personalizing the learning for the student[1]. The use of narration as the primary pedagogical method in elementary education was instituted by Charlotte Mason[1] (1842-1923). Ms. Mason was a 19th century school teacher from England who developed principles of education and psychology, and she eventually founded a college and system of education based on the practice and "art" of narration. Specifically, she had her students read portions of text and then retell portions of what they read back to the class and teacher. Not only would the students retell the information, they would also state conclusions and points of application that could be made from the information. She called narration the "act of knowing", such that by students retelling the information in their own words and formulating their own conclusions, the material would not only be internalized but personalized[1]. This process fits well within the general constructivist theory of

education as the initial narration, and especially the opportunity to summarize and suggest applications are techniques that can help develop scaffolding of new knowledge.

When Charlotte Mason began her style of education in the late 19th century, it was based on treating K-12 students as people who needed to experience their education as part of what she called an atmosphere (or their surroundings) and as a discipline of good habits. She emphasized that everything learned was to be seen as a part of interpreting life (not just memorization of facts). Her approach focused on primary source novels and books, instead of a single, compilation type of textbook, and it was the primary method used in the classroom. While the approach may seem overly simplistic, J.C. Smith concluded Mason's narration technique has proven profitable for "spatial memory" (basically creating a vehicle for cognitive mapping) and sequencing at the 4th grade level, and for improving writing at the middle school level[2]. His conclusions were that narrating is a natural learning device that "increases the opportunity for children to digest the knowledge" without "trying to find the answer the teacher wants."

1.2 Review of Related Research

Engineering programs, in general, attempt to develop technical problem-solvers through foundational mathematical, scientific problem solving married with conceptual knowledge. Conceptual understanding in college engineering has become a major pedagogical focus as it is more difficult to teach and develop than the traditional, mathematical, problem-based objectives. Narration, in the current study, is being investigated as a method for developing such conceptual understanding. Despite its success in K-12 education, the literature is silent on narration's impact in engineering at the collegiate level, where lecture-based and problem-focused instruction has been the historical norm. As such, this section reviews the various areas of related research under which narration could be classified (like active learning, use of multi-media, etc.)

There has been significant research in the area of active learning, under which Charlotte Mason's narration would likely be classified. The research on engineering instruction is replete with proof of active learning's success in general. Essentially, active learning involves meaningful learning activities in the classroom where students are engaged in manners other than just passive listening. Numerous agencies including the National Research Council and the National Science Foundation have documented the advantages of active learning and the numerous specific venues[3]. In engineering courses, this has typically meant collaborative and/or cooperative learning[4,5], or put simply, group work. More recently, problem-based learning has been increasingly incorporated and shown to be effective at enhancing learning[6-7]. Despite their success, these approaches often remain focused on problem solving, although they do help place the problems within meaningful contexts.

Compounding the focus on problem-solving is the often-used strategy of loading students with many problem-solving focused assignments and graded events in order to keep them engaged with the material. Not surprisingly, emphasizing (and rewarding) the association of problem identification with equation use does not lead to deeper conceptual understanding[8] or how to solve problems, especially in engineering. Further, by focusing their time on procedural assignments, students may actually spend less time in deeper reflection over the course material. Unfortunately, reflection is what leads to conceptual understanding and critical thinking about the material[9,10].

Within the engineering education community, recent studies also support the difficulty of developing deep learning and thinking. For example, using a "rich learning environment" with multi-media conducive to multiple learning styles also does not seem to solve the issue. For example, Taraban et al.[11] showed that teaching thermodynamics through a combination of text readings, listening to narration, and using computer-simulations and solved-problems through software does not lead to deep cognitive understanding (although it does increase cognitive activity). Jensen et al.[12] showed that use of multi-media in demonstrating conceptual understanding in introductory engineering is helpful, however it can be extremely instructor dependent. Narration was not used in any of the above studies, but we believe that it might have promise because of the way it forces students to individually interpret the text, and because of the evidence that suggests that it helps with conceptual mapping.

Outside the engineering realm, research studying remedial reading via what is known as reciprocal teaching has revealed beneficial elements at the collegiate level. Specifically, reciprocal teaching is defined as having "the tutor and students [take] turns leading a dialogue centered on pertinent features of the text" and the method has shown success in reading comprehension[13-14]. And while there are elements of reciprocal teaching which parallel elements of Charlotte Mason-like narration, namely "clarifying" and "summarizing" a particular text, it does not center on a student narrating a section of text out-loud in class "cold" as is done with narration.

1.3 The Need for Deeper Understanding

Within a broader context, evidence that the traditional collegiate-level strategies are not successful in developing deep thinking in students has made headlines in recent years. "Academically Adrift" by Arum and Roksa[9] concluded that colleges and universities graduate students with no significant increase in critical thinking. Meanwhile, over the past few decades, those authors also show average GPAs are on the rise. Although critical thinking isn't the only lens to view success (nor is the Collegiate Learning Assessment used in "Adrift" insulated from criticism), this book and other publications put academia on notice about a paradigm needing change and perhaps confirm what many have suspected: our pedagogical techniques have not been not as effective at developing students as we would like them to be.

Thus, the goal of the current research is to investigate narration as an approach to develop conceptual understanding at the college level and in engineering courses. While some might call this method at the college level too far on the "hand-holding" end of the spectrum, the authors theorize that narration will allow the students to learn the text at a deeper level by developing their ability to identify and synthesize the major points from the readings rather than focusing on the problems. Implementation of narration could reap greater benefits in deep learning than the assignment of additional "plug-and-chug" assignments. Student involvement during a class is one of the most important predictors of collegiate success[15] and the success of college-level narration could not only positively alter the way engineering is taught, but students could change their attitude about the course text as well as improve their depth of understanding of the material.

2.0 Presentation

2.1 Study Design

Our specific research question is, "Does the use of narration in a college engineering course increase students' conceptual understanding of the course's content as measured by their performance on conceptually oriented questions on an exam or quiz?" Specifically, we compared students' conceptual understanding of course material between a research group that used narration and a control group that received traditional lessons. Based on findings from a pilot study the prior semester, we also tracked student-specific narration participation (both as the narrator and as someone participating in the discussion following narration) on specific topics that were narrated and analyzed how those students performed on the questions targeting that narrated topic. Additionally, the students' subjective impressions of narration were captured, as we recognized the potential for students to resist new pedagogical techniques[16].

The data reported below were collected during the Spring of 2012 in a 300-level machine design course that enrolled both senior and junior level mechanical engineering majors. The research section was comprised of 21 students (17 juniors, 4 seniors), while the control section totaled 19 students (17 juniors, 2 seniors). Individual cadet performance on specific quiz questions was recorded for analysis, so that it was possible to correlate specific topics narrated or discussed in class to scores on questions assessing that specific content.

The research section incorporated narration (and subsequent discussion on the narration) for ~7-8 minutes within most lessons throughout the semester. The choice of 7-8 minutes for narration was based on the pilot study, which found that 3-5 minutes per lesson didn't allow enough time for the desired depth of discussion. Anecdotally, the students seemed to take the method more seriously when more time was given to it. During narration, the randomly chosen student read the selected portion of the text aloud, concluded his/her own main thoughts about what was read, and discussed these points. Other students were encouraged to participate and comment on the initial narrating student's thoughts. All discussion was guided by the instructor, correcting only when necessary. Students were informed that the narrated topics would target concepts that would be tested in the course exams, and that separate pop quizzes on those same concepts would be given throughout the semester to measure the effectiveness of the narration. The quizzes comprised 10% of their overall grade. All students who participated in the narration activity with reasonable effort were deemed proficient with respect to participation points. For the control group, both instructors taught their class using traditional lecture. It is important to note that the key, testable, conceptual sections of the text were covered during class for both groups, just using different approaches.

Because executing narration was expected to be unfamiliar to students, and such unfamiliarity often causes stress and anxiety, the initial classes of the semester were used to give some explanation of the narration technique as well as a demonstration and practice with no grade impact. Further, in order to increase student control (a factor associated with positive coping with stress), each student was allowed one "free pass", i.e. one opportunity to not participate in narration during the semester without penalty. The students were also surveyed toward the beginning of the course and again at the end of the course to determine how "comfortable" they were narrating as well as other subjective impressions of the

technique. Through constrained random selection, each cadet was expected to participate in a narration exercise at least twice during the semester.

2.2 Assessment Plan

2.2.1 Conceptual Knowledge (Quantitative)

There were 4 pop quizzes given throughout the semester that included questions designed to assess specific conceptual content, all of which was narrated at one point during the semester. Specific performance on questions relating to topics narrated or discussed was recorded. The quizzes were binary "all or nothing" quizzes whereby either the student was graded as understanding the concept or not.

2.2.2 Subjective (Qualitative) Feedback

In order to determine the impact of narration on student perceptions, subjective feedback was collected from the students at the beginning, around the middle, and toward the end of the semester. Pseudonyms were used for all subjective feedback in order to best obtain honest opinions of the methods without fear of attribution. Through a third party, students pseudonyms were revealed after grades were submitted so that pre-post subjective data could be linked to the quiz performance and incoming GPA. The questions were:

1) *Do you believe the incorporation of narration will help / has helped your learning of the course material? (strongly agree / agree / disagree / strongly disagree) Please explain.*
2) *Do you believe the incorporation of narration will provide / provided useful background for your mini-labs and labs? (strongly agree / agree / disagree / strongly disagree) Please explain.*
3) *Do you believe the incorporation of narration will provide / provided useful background for your Project Test Plan? (strongly agree / agree / disagree / strongly disagree) Please explain.*
4) *Do you feel comfortable participating in narration during class? (strongly agree / agree / disagree / strongly disagree) Please explain.*
5) *Do you feel narration increases your confidence in using the text book for learning / study? (strongly agree / agree / disagree / strongly disagree) Please explain.*
6) *Do you feel that listening to another student narrate in class improves your learning/understanding? (strongly agree / agree / disagree / strongly disagree) Please explain.*

Optional write-in comments were also collected during each of the feedback opportunities.

3.0 Assessment Results

3.1 Conceptual Learning

We first calculated the % of students in each group who answered the questions correctly. For the research (narration; N=21) group, 49.1% got questions correct while 53.3% of the control group (N=19) got the questions correct. This group difference was not significant, $F(1)=1.97$, $p = 0.17$. There also was no significant difference in incoming GPA between the two groups, ($p=.24$), so GPA was not included as a covariate.

However, because we tracked which students narrated and which students participated in the follow-on narration discussion, we were able to investigate performance on specific quiz questions by those who narrated or participated in the post-narration discussion compared to members of the research group who did neither. Table 1 summarizes these data. As shown in the far right column, there were a total of 17 narration events with 38 discussion events throughout the semester. Each event type row also shows the number of times that event type was associated with a correct and an incorrect response for the specific topic linked to the narration topic. Specific students' results fall under multiple event types, depending upon their role during different lessons. For example, if student 1 narrated on topic A one lesson, then he was included as part of the narrator row performance, but that same student 1 might have discussed during topic B coverage in a subsequent lesson. As such, his score on topic B's quiz would be included in the "Discusser" row. Results of students who didn't narrate or discuss the specific topic quizzed are shown in the "Non-Participation" row.

Table 1. Research Group Role Specific Performance. The percentages reported in each column shows the variation from what would have been expected from the null hypothesis, given a chi-squared analysis.

Event Type	Correct (% Dev)	Incorrect (% Dev)	Total Events

Narration Role	12 (+44)	5 (-42)	17
Discussion Role	21 (+14)	17 (-12)	38
Non-Participation	137 (-4)	155 (+4)	292
Total	170	177	347

Given the binary nature of the raw data, Chi-Square analyses were performed. The two middle columns show the % deviation of the observed chi-square frequency from the value that would be expected based on the null hypothesis. While only 17 individual counts of quiz response following narration are shown, the number of narrators getting their representative quiz question correct is 44% above the expected number. Those participating in the narration discussion had correct quiz responses 14% above the expected count. A Chi-Square analysis of the three roles, suggests a trend for differential impact with a p-value of 0.12.

3.2 Subjective Student Opinions

The feedback from the students (N=21) about the use of narration was collected toward the early, middle, and near the end of the semester. The answer range to each of the questions (strongly agree, agree, disagree, or strongly disagree) were given numerical weights of 3, 1, -1, and -3, respectively, and the answers to each question were averaged across students.

Table 2 summarizes the average student feedback for the narration class. The subjective data indicate that overall the students have a slightly decreasing opinion about the narration's benefits for learning course material and are more consistently negative regarding the benefits for supporting lab work and their final project. The students report that they feel comfortable narrating, with a slight increase across the semester. They do not report having greater confidence in using the textbook to study after having narrated than they had at the beginning of the semester. They also report that listening to another student in class does not increase their learning.

More interesting, for Q1 the individual results showed difference based on students' GPA coming into the course. The average GPA of the 9 students who thought the method was beneficial (Q1) was 3.09. In contrast, the average GPA of the 11 who thought narration was not beneficial to learning was 3.37. A one tailed t-test indicated that the better students tended to report a more negative view of the method than those who might tend to struggle more academically (p=.07). The other questions did not show a systematic influence of GPA.

Table 2. Average Student Opinion Feedback on Perceived Value of Narration (N=21)

	Students chose between: Strongly Agree (weighted value = 3), Agree (weighted value = 1), Disagree (weighted value = -1), or Strongly Disagree (weighted value -3)			
	Pre-Semester Average	Mid-Semester Average	End-of-Semester Average	Shift During Semester
Q1: Do you believe the incorporation of narration will help / has helped your learning of the course material?	.24	0	-.16	-0.4
Q2: Do you believe the incorporation of narration will provide / provided useful background for your mini-labs and labs?	-.4	-0.1	-.2	+.2

Q3: Do you believe the incorporation of narration will provide / provided useful background for your Project Test Plan?	-.5	-.3	-.4	+.1
Q4: Do you feel comfortable participating in narration during class?	.9	1	1.3	+.4
Q5: Do you feel narration increases your confidence using the textbook for learning/study?	.3	.05	.1	-.2
Q6: Do you feel that listening to another student narrate in class improves your learning?	-.8	-1	-.8	0

The individual write-in comments also spanned the spectrum, with example positive comments being "It helps to point out important sections of the book" and "I don't mind others' reading…it helps to hear another perspective." Some representative comments from those with negative opinions were "I get distracted when others read," "I can read the text myself," and "Just takes time out of class." A distinct subset of comments suggested that some students believed they would more clearly benefit from the instructor using the time to lecture rather than listen to other students grapple with the material. However, compared to the pilot study semester there were fewer such comments.

3.3 Findings

Instructors found that implementation of the narration approach required little additional course preparation and fit naturally into an upper-level engineering course that had traditionally been lecture and problem-solving focused. Overall, when students are compared by condition (narration versus control), we found no difference in conceptual understanding. However, when performance was tracked for the specific narrator/participant/non-participant roles on the topic they narrated/discussed, we did find a trend for benefit to performance, with the largest benefits for those who narrated and smaller benefits for those who participated in follow-on discussion. Because the specific students who narrated each lesson were not self-selected, but rather, randomly selected by the instructor, the benefits to performance cannot entirely be due to having the more prepared students choose to narrate.

In addition to student role making an impact, the student characteristic of GPA influences perceptions of the benefit of the narration approach. Higher GPA students tended to report lower levels of appreciation for narration's benefits related to learning course material than did lower GPA students. Regardless of GPA, students were in agreement that narrations were not helpful for labs and their projects and they did not believe that listening to other students improved their learning.

Based on a comparison of student comments from the pilot study and the spring semester, the additional time spent in narration and the inclusion more instructor interjection during discussion seemed to lead to more positive impressions of the use of class time for narration. As mentioned above, the pilot study method only allotted 3-5 minutes per lesson rather than 7-8 minutes per lesson. Note that Smith's dissertation on Charlotte Mason's effective use of narration stated that it was used pervasively for large portions of class time[2].

4.0 Conclusions

Our research suggests that narration aids learning for those who either participate in the discussion or narrate themselves. As it was implemented, it does not benefit the rest of the class members who are simply listening to the narration/discussion. We conclude that unless the student is actively involved in the method, it has no benefit and in fact it

may decrease learning as measured by performance on a quiz related to the topic of narration. The decrease in learning may be due to factors related to student attention and expectations. Students often "discount" inputs from other students during lessons as they are not the authoritative, expert words they expect from the instructor. In fact, many of our students wrote comments suggesting that they could have gotten more from the narration time if the instructor had simply told them the material. However, decades of research on learning and memory shows that attention to and active engagement with the material is what enhances learning, not simply "hearing the expert words" of an instructor[17].

Also related to this interpretation of student expectations was the finding that the students with lower grades were more likely to have a favorable view toward the potential benefits of the method than the better students. These students might be less likely to discount the inputs of the other students, because most of the other students were doing better than them in the class. Further, increasing the amount of class time dedicated to narration seemed to increase student perceptions of its value. This shift in perceptions from the pilot study could be because the longer discussion allowed more input from the expert instructor. Additionally, the extra time could have sent a stronger message that the instructor believed narration was a beneficial use of class time. Given the positive trends and the low instructor burden, narration has continued to be used in subsequent semesters in different engineering courses at the Academy. Recent anecdotal student feedback revealed that they appreciated narration because it made them stop, read, discuss, and "figure out exactly what's going on."

Future research should more deeply explore student expectations and investigate how they might interact with the implementation of student-focused pedagogies such as narration. Future research should also investigate whether further increasing the narration time has benefits, both because more students would be able to participate during a given lesson and because more time would be spent in discussion of the material. Long-standing research indicates *any* intentional discussion, in general, surpasses traditional lectures in material retention[18].

A second set of factors to consider with respect to implementation of narration relate to student comfort with the procedure. While our students reported that they were comfortable with the technique (and that comfort increased across the semester), narration requires a student to read out loud in front of other students, which is likely to be somewhat anxiety provoking to the general higher education population of students. Our students were upper-class-level students in a relatively small section who had had many prior courses together. Thus, future research should explore the use of the technique in lower-level courses where students may not know each other and in university settings that involve larger class sizes. Prior student experience with narration in K-12 education might also influence the comfort students report. Earlier implementation of narration might also lead to greater benefits as students' learning habits and expectations are not yet set.

As with any pedagogical technique, instructor implementation strategies will be crucial to the successful implementation of narration. Pertinent examples include not only the amount of time in class dedicated to narration, but also the transparent explanation of the benefits of participation, the intentionally calling on students who seem "tuned out", or the explicit reinforcement of participation through encouragement and recognition or points. The increased learning for those who actively participate supports the use of the narration approach, but it also further highlights that larger success will depend upon getting all students involved.

We acknowledge that there may be underlying factors supporting narration's apparent success. Namely, Ruhl et al.[19] and Di Vesta[20] showed significant benefits involving any "pause procedure" used during a lecture, where there is additional time for reflection. As the use of narration is explored, the amount of time spent pausing should be explored. Additionally, according to Bransford et al.[21], any time spent addressing student misconceptions during a lecture has been noted as a critical element of effective teaching. Thus, as narration is investigated further, such factors should be studied as well.

In the quest for deeper, conceptual understanding in engineering education, the road is complex. Increasing student interaction with the material in varying ways is often an instructor's means to achieve such understanding. The use of narration-based discussion for sections of standard, engineering course textbooks is a method worth considering.

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